# The Influence of Health Literacy on Colorectal Cancer Screening Knowledge, Beliefs and Behavior

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*Objective:* To determine if health literacy is associated with knowledge of colorectal cancer (CRC) and CRC screening tests, with perceived benefits and barriers to CRC screening, with perceived risk of CRC, with reported self-efficacy for completing CRC screening and with receipt of CRC tests.

*Methods:* A convenience sample of 99 subjects completed a health literacy assessment, the Rapid Estimate of Adult Literacy in Medicine (REALM) and a structured interview.

*Results:* Limited or inadequate health literacy was significantly associated with less knowledge about CRC and CRC screening and with more reported barriers to completing fecal occult blood testing (FOBT) and colonoscopy in multivariate analysis. Health literacy was not associated with perceived benefits or reported self-efficacy for completing FOBT or colonoscopy, with perceived risk of developing CRC or with completing CRC tests. However, our small sample size limited our power to detect differences.

*Conclusions:* Patients with limited health literacy have less knowledge about CRC and CRC screening and report more barriers to completing FOBT and colonoscopy. Interventions to improve CRC screening should consider the health literacy of patients, especially when addressing barriers to screening. Future studies are needed to better define the role of health literacy in CRC screening.

**Key words:** colorectal ■ cancer ■ barriers ■ attitudes and beliefs ■ knowledge

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## INTRODUCTION

Colorectal cancer (CRC) is the third most common cause of cancer and the second leading cause of cancer death among men and women.[1] Fortunately, screening for CRC has been demonstrated in multiple studies to significantly reduce morbidity and mortality. Thus, CRC screening is recommended by the American Cancer Society, the U.S. Preventive Task Force and the U.S. Multisociety Task Force on Colorectal Cancer.[2-4] Five potential CRC screening strategies are recommended for average-risk individuals aged ≥50 years: 1) annual fecal occult blood testing (FOBT), 2) flexible sigmoidoscopy every five years, 3) annual FOBT plus flexible sigmoidoscopy every five years, (4) double-contrast barium enema every five years, or 5) colonoscopy every 10 years.[2,4] Despite these recommendations, many people do not undergo CRC testing. For example, the 2004 Behavioral Risk Factor Surveillance System (BRFSS) survey found that among respondents aged ≥50 years, only 57.3% had complete CRC testing according to guideline recommendations.[5]

Several studies have explored factors related to the use of specific CRC tests,[6-10] and a few studies have examined factors related to getting tested for CRC in general.[6,10-12] Knowledge about cancer, perceived susceptibility and health-promoting behavior such as regular medical check-ups have been found to be positively correlated with CRC screening adherence in some studies.[9] A health provider's recommendation also has a positive influence on completion of CRC testing.[6,13]

Patients with less education and low income are less likely to be screened for CRC.[14,15] Limited literacy skills, which are common among this patient population, may be an important factor that influences CRC screening behavior. Health literacy is defined as "the capacity of an individual to obtain, interpret, and understand basic health information and services and the competence to use such information and services in ways which are health enhancing".[16] More than 90 million Americans have poor literacy skills, and studies have suggested that low health literacy can be associated with less knowledge about cancer screening in general, less screening

participation and worse clinical outcomes.[17-19] Little is known about how health literacy affects knowledge, attitudes and behaviors regarding CRC testing. A few cross-sectional studies have shown that low health literacy may be associated with worse knowledge[20-22] and lower cancer risk perception,[20,21] but results have been conflicting. No previous study has examined in depth how health literacy may correlate with perceived risk, perceived benefits and barriers and self-efficacy for CRC testing. In this study, using a conceptual framework based on the PRECEDE-PROCEED Model (PPM)[23] and the Health Belief Model (HBM),[24] we hypothesized that low health literacy would be associated with low knowledge, negative attitudes and beliefs and low reported self-efficacy for CRC testing and with low receipt of CRC tests.

# METHODS

## Participants

Subjects for the study were recruited from a community health clinic in Nashville, TN from September 2004 to June 2005. The community health clinic is located in a medically underserved community adjacent to a public housing project, and the clinic provides accessible and affordable healthcare to a wide range of patients with a special focus on vulnerable populations. To be eligible for this study, a subject had to be ≥50 years of age, receive primary care services at the community clinic, be English-speaking, and have either TennCare (Tennessee's Medicaid program) or Medicare insurance coverage. Because both TennCare and Medicare reimburse for CRC screening tests, including colonoscopy,

**Table 1. Demographic characteristics of study participants**

| | Total Sample (N=99) | Limited Health Literacy (N=29) | Adequate Health Literacy (N=70) | P Value |
|---|---|---|---|---|
| Mean Age (SD) | 59.5 (7.8) | 60 (8.8) | 60 (7.5) | 0.99 |
| Sex, % | | | | |
| Male | 44 | 45 | 60 | |
| Female | 56 | 55 | 40 | 0.17 |
| Race, % | | | | |
| White | 66 | 48 | 73 | |
| Black or African American | 32 | 52 | 24 | |
| American Indian/Alaskan native | 1 | 0 | 1 | |
| Asian | 1 | 0 | 1 | 0.03 |
| Hispanic Ethnicity, % | 1 | 0 | 1 | 1.0 |
| Marital Status, % | | | | |
| Married | 22 | 31 | 19 | |
| Divorced | 36 | 34 | 37 | |
| Widowed | 16 | 14 | 17 | |
| Single and never married | 18 | 17 | 19 | |
| Not married and living with partner | 3 | 0 | 4 | |
| Separated | 4 | 3 | 4 | 0.82 |
| Income, % | | | | |
| ≤$15K | 65 | 79 | 59 | |
| >$15–$30K | 19 | 14 | 21 | |
| >$30–$50K | 9 | 3 | 11 | |
| >$50–$75K | 2 | 0 | 3 | |
| >$75–$100K | 0 | 0 | 0 | |
| >$100–$150K | 1 | 0 | 1 | |
| ≥$150K | 0 | 0 | 0 | |
| Don't know/refused | 4 | 3 | 4 | 0.56 |
| Insurance, % | | | | |
| TennCare | 56 | 34 | 64 | |
| Medicare | 11 | 14 | 10 | |
| Both | 32 | 52 | 24 | |
| Refused | 1 | 0 | 1 | 0.02 |
| Education, Highest Completed, % | | | | |
| ≤8th grade | 14 | 38 | 4 | |
| 9th–12th grade | 44 | 48 | 43 | |
| >12th grade | 41 | 14 | 53 | <0.001 |

we elected to limit participation by type of insurance coverage in order to eliminate insurance status as a barrier. This study was approved by the Vanderbilt institutional review board.

A convenience sample was recruited in one of three ways: 1) signing an interest form after reading a pamphlet describing the study in the clinic waiting room, 2) signing an interest form after being told about the study by their primary care provider, or 3) contacting study staff after receiving an informational pamphlet in the mail. Interested participants were given a description of the research project by study staff, had their eligibility confirmed, and informed consent was obtained. Of the 158 eligible subjects who indicated interest in participating, 99 (63%) completed both the Rapid Estimate of Adult Literacy in Medicine (REALM) and the structured interview. Patient subjects completing the structured interview received $10.

## Instruments

Enrolled participants completed the interview in person or over the telephone. Each participant completed a health literacy assessment using the REALM.[25,26] The REALM is a well-validated measure of health literacy that is highly correlated with other standardized tests of word recognition, reading comprehension and literacy, including the Peabody Individual Achievement Test-Revised (PIAT-R), the Wide Range Achievement Test-Revised (WRAT-R) and the Slosson Oral Reading Test-Revised (SORT-R).[25,26] The structured interview was read to each participant by study staff. The structured interview included items that assessed demographic characteristics (e.g., age, marital status, income, education), cancer screening behavior history, CRC knowledge (risk, screening, causes, treatment, cure), perceived risk of CRC, perceived benefits and barriers to and reported self-efficacy for screening with FOBT and colonoscopy. Benefits and barriers to and self-efficacy for screening with flexible sigmoidoscopy was not assessed because, when queried prior to the start of this study, the community health clinic providers stated they preferentially referred their TennCare and Medicare patients for colonoscopy over flexible sigmoidoscopy.

Subjects were asked if they had "ever done a stool blood test at home and mailed the card back to your doctor's office or lab" and if they had "ever had a colonoscopy" or "flexible sigmoidoscopy" and how long ago their last test(s) was. These questions were previously used and validated.[27] Definitions of a stool blood test, colonoscopy and flexible sigmoidoscopy were provided to all participants. Questions regarding CRC screening with barium enema, an acceptable form of screening, were not asked, as patients from this particular clinic were not routinely referred for this procedure.

Questions regarding knowledge, benefits and barriers, perceived risk and self-efficacy were based on the con-

**Table 2. Reported knowledge, benefits, barriers and self-efficacy for colorectal cancer testing by literacy status**

| | Limited Health Literacy, % Correct or Item Mean (SD) (n=29) | Adequate Health Literacy, % Correct or Item Mean (SD) (n=70) | P Value, Unadjusted | P Value, Adjusted* |
|---|---|---|---|---|
| CRC Knowledge** | 64% (0.18) | 75% (0.19) | 0.008 | 0.24 |
| Benefits† | | | | |
| FOBT‡ | 3.83 (0.56) | 3.90 (0.48) | 0.52 | 0.92 |
| Colonoscopy§ | 3.93 (0.52) | 3.96 (0.47) | 0.77 | 0.66 |
| Barriers† | | | | |
| FOBT¶ | 2.67 (0.68) | 2.12 (0.46) | <0.001 | <0.001 |
| Colonoscopy# | 2.58 (0.68) | 2.24 (0.41) | 0.003 | 0.009 |
| Self-Efficacy† | | | | |
| FOBT[1] | 3.87 (0.41) | 3.93 (0.34) | 0.45 | 0.44 |
| Colonoscopy[2] | 3.92 (0.39) | 3.99 (0.32) | 0.34 | 0.52 |

CRC: colorectal cancer; FOBT: fecal occult blood testing; * Adjusted for age, sex, race, insurance status and literacy status; ** There were 15 knowledge questions, including statements about family history risk, dietary risks, CRC symptoms, CRC tests, screening recommendations, and detection and treatment of CRC. Respondents answered true or false; † Individual benefit, barrier and self-efficacy statements were on a Likert scale with 1=strongly disagree, 2=disagree, 3=neutral or don't know; 4=agree, and 5=strongly agree; ‡ FOBT benefit statements included beliefs that 1) benefits outweigh any difficulty, 2) FOBT helps find CRC early, 3) FOBT decreases chances of dying from CRC, 4) FOBT will cause less worry, and 5) treatment may not be as bad if CRC found early; § Colonoscopy benefit statements included beliefs that colonoscopy 1) helps find CRC early, 2) decreases chances of dying from CRC, and 3) will cause less worry; ¶ FOBT barrier included statements 1) not understanding what to do, 2) finding it embarrassing, 3) too time consuming, 4) fear of finding something wrong, 5) fear of pain, 6) cost concerns, 7) not having any problems or symptoms, and 8) transportation problems; # Colonoscopy barrier statements included 1) not understanding what will be done, 2) finding test embarrassing, 3) too time consuming, 4) fear of finding something wrong, 5) fear of pain, 6) having to follow a special diet and taking laxative, 7) cost concerns, 8) not having any problems or symptoms, 9) possibility of bleeding or colon tearing, and 10) transportation problems; 1: The eight FOBT self-efficacy statements queried a respondent's perception of their ability to obtain and complete FOBT; 2: The 13 colonoscopy self-efficacy statements queried a respondent's perception of their ability to schedule a colonoscopy, complete the preparation for colonoscopy and overcome any concerns about the test.

ceptual framework for this current study derived from the PPM[23] and the HBM.[24] The PPM suggests that predisposing and enabling factors influence behavioral change. Examples of predisposing factors are demographic variables, knowledge and beliefs, whereas examples of enabling factors include access to healthcare and recommendations from health care providers. The HBM as applied to cancer screening postulates that for individuals to undergo screening, they must believe: 1) they are susceptible to developing cancer, 2) that developing cancer is serious and would impact their well-being, 3) that screening would prevent them from developing cancer, and 4) they can complete cancer screening (self-efficacy).

Subscales for knowledge, benefits, barriers and self-efficacy used in this study were previously developed and validated.[27,28] Cronbach's alphas for subscales in this study were 0.76 for the knowledge scale, 0.67 for the FOBT benefits scale, 0.82 for the FOBT barriers scale, 0.65 for the colonoscopy benefits scale, 0.82 for the colonoscopy barriers scale, 0.85 for the FOBT self-efficacy scale and 0.89 for the colonoscopy self-efficacy scale. The knowledge subscale included 15 statements regarding family history risk, dietary risks, CRC symptoms, CRC tests, screening recommendations, and detection and treatment of CRC. Participants were asked to determine if the knowledge statements were true or false. There were five statements concerning the benefits of FOBT (belief that benefits outweigh any difficulty, helps find CRC early, decreases chance of dying from CRC, causes less worry, treatment may not be as bad if CRC found early) and eight statements regarding barriers to FOBT (not understanding what to do, embarrassing, time consuming, fear of finding something wrong, fear of pain, cost concerns, not having any problems or symptoms, transportation problems). There were three statements about the benefits of colonoscopy (helps find CRC early, decreases chances of dying from CRC, causes less worry) and 10 statements pertaining to barriers to colonoscopy (not understanding what to do, embarrassing, time consuming, fear of finding something wrong, fear of pain, having to follow special diet and take a laxative, cost concerns, not having problems or symptoms, possibility of bleeding or colon tearing, transportation problems). The eight self-efficacy statements regarding FOBT queried a respondent's perception of their ability to obtain and complete FOBT; the 13 self-efficacy statements regarding colonoscopy queried a respondent's perception of their ability to schedule a colonoscopy, complete the preparation for colonoscopy and overcome any concerns about the test. Individual item responses for benefit, barrier and self-efficacy statements were on a five-point Likert scale ranging from 1=strongly disagree to 5=strongly agree. There were four individual perceived risk statements that asked participants to rate their chances of getting CRC in the next 10 years and compared to their peers.

## Variables

Subjects were categorized as having limited health literacy (defined as ≤8th grade literacy level on the REALM; REALM score of 0–60) or adequate health literacy (defined as ≥9th grade literacy level on REALM; REALM score of 61–66), which is consistent with current literature.[29-31] The percent of answers to knowledge statements correctly answered is reported, stratified by limited or adequate health literacy status. Scale means with standard deviations were calculated for benefits and barriers to and self-efficacy for FOBT and colonoscopy, and results are reported, stratified by health literacy status. Percentages of participants responding positively to individual perceived risk statements were determined and compared to negative and neutral responses. Percentages of participants, stratified by health literacy status, who were "up to date" for CRC testing are presented. "Up to date" for CRC testing was defined as having completed an FOBT test in the last year, a flexible sigmoidoscopy in the last five years or having ever had a colonoscopy (time interval was not asked for colonoscopy).

## Statistical Analysis

All analyses were performed using SAS® version 9.1 (SAS Institute Inc., Cary, NC). Bivariate analyses of categorical sociodemographic variables (sex, race, marital status, income, insurance and education) by health literacy status (limited or adequate) were performed using Chi-squared testing; t testing was used for the age variable. A p value of $<0.05$ was used to indicate significance. T tests were used to compare percents for knowledge and perceived risk statements and to compare mean scores for the benefits, barriers and self-efficacy scales.

Multivariate linear regression analyses were performed to allow estimation of the impact of health literacy on knowledge, benefits, barriers, reported self-efficacy and perceived risk while controlling for sociodemographic variables. Education was not included in the multivariate analyses because education and the REALM were highly correlated (correlation coefficient 0.6). We used logistic regression to estimate the effect of health literacy on completion of CRC tests; odds ratios and 95% confidence intervals were calculated. Additionally, multivariate analyses were rerun in which the REALM was included as a continuous measure. To correct for the non-normal distribution of the REALM in these additional analyses, we used the log transformation of the REALM. Results obtained were compared to results of original models (results not shown). Generally, results remained the same (<10% difference) except where noted. Tests for interaction between model variables (health literacy with age, sex, race and insurance) were performed by calculating the difference between models with and without cross-product terms. No significant effect modification was found (results not shown).

# RESULTS

## Demographics and REALM Scores

The demographic characteristics of the study population are shown in Table 1. The average age of participants was 59.5 years and 56% were female. By self-identification, 66% were white and 32% were African American. Sixty-five percent of subjects reported an annual income of ≤$15,000. For insurance, 56% reported having TennCare (Medicaid), 11% Medicare and 32% reported having both. Fourteen percent had <8th grade education.

The mean REALM score was 56.6 (SD 17.2, range 0–66). Overall, 29% of subjects had limited health literacy (≤8th-grade level). There were no significant differences between subjects who had limited health literacy and those with adequate health literacy in mean age, gender, marital status and income. There were differences by race (p=0.03), insurance (p=0.02) and education (p<0.001).

## Knowledge

Of the 15 knowledge statements, subjects with limited health literacy correctly answered 64%, compared to 75% in subjects with adequate health literacy (p=0.008). In adjusted analyses, health literacy was not significantly associated with knowledge about CRC and CRC screening (p=0.24) (Table 2). However, health literacy as a continuous measure was significantly associated with knowledge in adjusted analysis (p=0.02). Age, sex, race and insurance status were not significantly associated with knowledge.

## Benefits and Barriers

Health literacy was not significantly associated with reporting more benefits to completing either FOBT or colonoscopy in adjusted analysis (Table 2). However, female sex (adjusted p=0.01) was significantly associated with reporting more benefits for FOBT but not for colonoscopy. Limited health literacy was associated with reporting more barriers to completing both FOBT (p<0.001) and colonoscopy (p=0.009) in adjusted analyses. Age, race and insurance status were not associated with benefits or barriers to FOBT or colonoscopy.

## Perceived Risk and Self-Efficacy

In adjusted analyses, there were no statistically significant associations between health literacy and respondents who believed they were likely to get CRC in the next 10 years, who believed that they were likely to get CRC in the next 10 years compared to others their own age, who rated their chance of getting CRC highly or who rated their chances of getting CRC as greater than others their age (results not shown). In addition, there was no association between health literacy and reported self-efficacy for completion of either FOBT or colonoscopy in adjusted analyses (Table 2). Age, sex, race and insurance status were not significantly associated with perceived risk or self-efficacy.

**Table 3. Completion of colorectal cancer testing by literacy status**

| | Reported Percent | OR, Unadjusted (95% CI) | OR, Adjusted* (95% CI) |
|---|---|---|---|
| Up-to-date CRC testing† | 61.6 | n/a | n/a |
| Limited | 51.7 | 0.56 (0.23–1.35) | 0.67 (0.24–1.83) |
| Adequate | 65.7 | – | – |
| Had FOBT in last year | 12.1 | n/a | n/a |
| Limited | 13.8 | 1.24 (0.34–4.49) | 1.26 (0.30–5.31) |
| Adequate | 11.4 | – | – |
| Ever had FOBT | 45.5 | n/a | n/a |
| Limited | 34.5 | 0.53 (0.21–1.29) | 0.74 (0.27–2.01) |
| Adequate | 50.0 | – | – |
| Ever had colonoscopy | 52.5 | n/a | n/a |
| Limited | 37.9 | 0.43 (0.18–1.05) | 0.48 (0.18–1.32) |
| Adequate | 58.6 | – | – |
| Had sigmoidoscopy in last five years | 10.1 | n/a | n/a |
| Limited | 6.9 | 0.57 (0.11–2.88) | 0.41 (0.07–2.55) |
| Adequate | 11.4 | – | – |
| Ever had sigmoidoscopy | 24.2 | n/a | n/a |
| Limited | 17.0 | 0.56 (0.19–1.68) | 0.65 (0.20–2.14) |
| Adequate | 27.0 | – | – |

CRC: colorectal cancer; FOBT: fecal occult blood testing; * Adjusted for age, sex, race, insurance status and literacy status; † To be up to date for CRC testing, a participant had to have: 1) FOBT in last year, 2) colonoscopy at any time, or 3) flexible sigmoidoscopy in the last five years.

## Colorectal Cancer Screening Behavior

Overall, 61% of participants were up to date for CRC testing, defined as having a FOBT in the last year, a flexible sigmoidoscopy in the last five years or a colonoscopy at any time (Table 3). Fewer participants with limited health literacy (52%) were up to date for CRC testing when compared to participants with adequate health literacy (66%), but the difference was not statistically significant (OR=0.67; 95% CI: 0.24–1.83). There were also no statistically significant associations between health literacy and the type of individual test completed (FOBT, flexible sigmoidoscopy or colonoscopy) in adjusted analyses. Increasing age was significantly associated with having ever had a colonoscopy and being up to date for CRC testing. Additionally, having Medicare insurance was significantly associated with having ever had a colonoscopy.

## DISCUSSION

In our study, we found that limited health literacy was associated with less knowledge about CRC and CRC screening (REALM as a continuous measure). A few published studies have examined the association between health literacy and cancer screening knowledge. Two separate studies found that women with low health literacy skills had less knowledge about breast and cervical cancer screening and the use of mammography and Pap smears as cancer screening tests.[32,33] For CRC, a focus group study reported that patients with low literacy skills were familiar with but had little relevant knowledge about CRC and CRC screening tests, and did not understand the concept of cancer prevention by screening or the benefits or early detection.[34] Three qualitative studies examined the association of health literacy with CRC screening knowledge. Two[20,22] of the studies found that health literacy was a significant predictor of knowledge, similar to our study, whereas one did not.[21]

Perceived susceptibility, benefits and barriers have inconsistently been both positively and negatively associated with adherence to CRC screening.[9] In our study, we found that limited health literacy was associated with being more likely to perceive barriers but not benefits to completing FOBT and colonoscopy. We did not find that health literacy impacted whether or not our participants believed they were more or less likely to develop CRC. Similarly, Guerra and others reported that health literacy was not a significant predictor of CRC screening beliefs or attitudes.[21] In contrast, Dolan and others reported low health literacy was associated with negative attitudes about FOBT but not flexible sigmoidoscopy, and with a belief in heightened susceptibility to CRC.[20] In addition, we did not find that health literacy status was associated with reported self-efficacy for completion of CRC tests. To our knowledge, no other study has examined this association.

Even though we found that limited health literacy was associated with less knowledge and with reporting more barriers to completing CRC testing, we did not find a statistically significant association between health literacy and completion of CRC testing, similar to other studies that have examined this association.[21,22] However, the small sample size of our study and others[21,22] limits the power to examine this association and should be investigated in larger populations before literacy is dismissed as a predictor of CRC testing.

It is possible that having adequate health literacy by itself may not sufficient for a patient to complete CRC screening. The determinants of CRC screening are likely numerous and complex, with influences from the patient, the patient's family and community, the provider, and the healthcare system. For example, increases in screening mammography were due, in part, to large-scale public education efforts over many years. Comparable education programs about CRC and CRC screening are relatively more recent, and their impact may not yet be fully realized. In addition, providers may fail to adequately or appropriately discuss the importance of CRC screening with their patients, and it may be that patients need this recommendation to complete screening. In support of this, patients have reported the important influence of physician recommendation on their receipt of CRC screening in several studies.[6,13,35-37]

There are several limitations to our study. First, its cross-sectional design did not allow us to ascertain whether health literacy was causally associated with our outcomes. It is possible that health literacy is simply a marker for another factor such as preventive health-seeking behavior and that we did not adequately address all possible confounders. We relied on patient self-report for completion of CRC testing. In general, patients overestimate their use of CRC tests,[38] which would limit the ability to discern differences in testing rates. In our study, we did not ask about double-contrast barium enema (DCBE) because, in our experience, very few of our patient population receive this type of CRC testing. However, if a participant had received a DCBE and not one of the other tests, we would have misclassified that person as not having received CRC testing. In addition, we asked about ever having received colonoscopy and did not determine if the test had been performed in the last 10 years, according to the recommended interval between normal tests. As a result, we likely overestimated the number of participants who were up to date with CRC testing. The reliability of the benefit subscales for FOBT and colonoscopy (alphas 0.67 and 0.65, respectively) were lower than the other subscales (alphas 0.76-0.89), and may have contributed to the lack of association seen between health literacy and perceived benefits. Patients who chose to participate may not have been representative of the general patient population, leading to selection bias. In addition, although the REALM is a good measure of

reading and interpretation, it does not capture numeracy, the skill of understanding numbers (which is important for measuring overall health literacy).[39,40]

## CONCLUSIONS

In our study, limited health literacy was associated with less knowledge about CRC and CRC screening and with reporting more barriers to completing FOBT and colonoscopy, but was not associated with perceived benefits or reported self-efficacy for completing FOBT or colonoscopy, with perceived risk of developing CRC or with completing CRC testing.

Health literacy may be an important factor influencing CRC screening knowledge, attitudes, beliefs and behavior, and further work needs to be done in this area. CRC screening interventions that include procedures to increase knowledge and decrease barriers should consider the health literacy status of patients and should include strategies targeted towards patients with limited health literacy. A recent review of websites containing CRC information concluded that many sites were too difficult for the average American adult to understand and much too difficult for adults with limited health literacy.[41] Another consideration is the availability of several CRC testing options which requires patients to participate in decision-making. One study reported that lower education attainment, which often is seen with low health literacy, was associated with a preference by patients to have the physician make all CRC screening decisions.[42] This finding has implications not only in provider–patient communications about CRC screening but also for interventions designed to improve CRC screening. Physicians and other healthcare providers need to be educated about how to communicate CRC screening information and improve decision-making in patients with limited health literacy. Future studies are needed to help better define the role of health literacy in CRC screening and the role of specific interventions designed to improve screening for patients with limited health literacy.

## REFERENCES


1. American Cancer Society. Cancer Facts and Figures 2007. Atlanta, GA: American Cancer Society; 2007.

2. Smith RA, Cokkinides V, Eyre HJ. American Cancer Society guidelines for the early detection of cancer, 2006. *CA Cancer J Clin*. 2006;56:11-25.

3. U.S. Preventive Services Task Force. Screening for colorectal cancer: recommendation and rationale. *Ann Intern Med*. 2002;137:129-131.

4. Winawer S, Fletcher R, Rex D, et al. Colorectal cancer screening and surveillance: clinical guidelines and rationale—Update based on new evidence. *Gastroenterology*. 2003;124:544-560.

5. Centers for Disease Control and Prevention. Increased use of colorectal cancer tests-United States, 2002 and 2004. *MMWR Morb Mortal Wkly Rep*. 2006;55:308-311.

6. Mandelson MT, Curry SJ, Anderson LA, et al. Colorectal cancer screening participation by older women. *Am J Prev Med*. 2000;19:149-154.

7. Shapiro JA, Seeff LC, Nadel MR. Colorectal cancer-screening tests and associated health behaviors. *Am J Prev Med*. 2001;21:132-137.

8. Sutton S, Wardle J, Taylor T, et al. Predictors of attendance in the United Kingdom flexible sigmoidoscopy screening trial. *J Med Screen*. 2000;7:99-104.

9. Vernon SW. Participation in colorectal cancer screening: a review. *J Natl Cancer Inst*. 1997;89:1406-1422.

10. Walsh JM, Posner SF, Perez-Stable EJ. Colon cancer screening in the ambulatory setting. *Prev Med*. 2002;35:209-218.

11. Lemon S, Zapka J, Puleo E, et al. Colorectal cancer screening participation: comparisons with mammography and prostate-specific antigen screening. *Am J Public Health*. 2001;91:1264-1272.

12. Zapka JG, Puleo E, Vickers-Lahti M, et al. Healthcare system factors and colorectal cancer screening. *Am J Prev Med*. 2002;23:28-35.

13. Taylor F, Lessler D, Mertens K, et al. Colorectal cancer screening among African Americans: The importance of physician recommendation. *J Natl Med Assoc*. 2003;95:806-812.

14. Liang SY, Phillips KA, Nagamine M, et al. Rates and predictors of colorectal cancer screening. *Prev Chronic Dis*. 2006;3:A117.

15. Pollack LA, Blackman DK, Wilson KM, et al. Colorectal cancer test use among Hispanic and non-Hispanic U.S. populations. *Prev Chronic Dis*. 2006;3:A50.

16. Joint Committee on National Health Education Standards. National health education standards: achieving health literacy. Reston, VA: Association for the Advancement of Health Education; 1995.

17. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs. Health literacy: Report of the Council on Scientific Affairs. *JAMA*. 1999;281:552-557.

18. DeWalt DA, Berkman ND, Sheridan S, et al. Literacy and health outcomes: a systematic review of the literature. *J Gen Intern Med*. 2004;19:1228-1239.

19. Institute of Medicine. Health Literacy: a Prescription to End Confusion. Washington, DC: National Academies Press; 2004.

20. Dolan NC, Ferreira MR, Davis TC, et al. Colorectal cancer screening knowledge, attitudes, and beliefs among veterans: does literacy make a difference? *J Clin Oncol*. 2004;22:2617-2622.

21. Guerra CE, Dominguez F, Shea JA. Literacy and knowledge, attitudes, and behavior about colorectal cancer screening. *J Health Commun*. 2005;10:651-663.

22. Miller DP Jr, Brownlee CD, McCoy TP, et al. The effect of health literacy on knowledge and receipt of colorectal cancer screening: a survey study. *BMC Fam Pract*. 2007;8:16.

23. Green LW, Kreuter MW, eds. Health Promotion Planning: An Educational and Environmental Approach. Mountain View, CA: Mayfield Publishing Company; 1991.

24. Strecher VJ, Rosenstock IM. The health belief model. In: Glanz K, Lewis FM, Rimer BK, eds. Health Behavior & Health Education: Theory, Research & Practice. San Francisco, CA: Jossey-Bass Inc.; 1997:41-59.

25. Davis TC, Crouch MA, Long SW, et al. Rapid assessment of literacy levels of adult primary care patients. *Fam Med*. 1991;23:433-435.

26. Davis TC, Long SW, Jackson RH, et al. Rapid estimate of adult literacy in medicine: a shortened screening instrument. *Fam Med*. 1993;25:391-395.

27. Menon U, Champion VL, Larkin GN, et al. Beliefs associated with fecal occult blood test and colonoscopy use at a worksite colon cancer screening program. *J Occup Environ Med*. 2003;45:891-898.

28. Rawl S, Champion V, Menon U, et al. Validation of scales to measure benefits of and barriers to colorectal cancer screening. *J Psychosoc Oncol*. 2001;19:47-63.

29. Lindau ST, Basu A, Leitsch SA. Health literacy as a predictor of follow-up after an abnormal Pap smear: a prospective study. *J Gen Intern Med*. 2006;21:829-834.

30. Lincoln A, Paasche-Orlow MK, Cheng DM, et al. Impact of health literacy on depressive symptoms and mental health-related: quality of life among adults with addiction. *J Gen Intern Med*. 2006;21:818-822.

31. Rothman RL, DeWalt DA, Malone R, et al. Influence of patient literacy on the effectiveness of a primary care-based diabetes disease management program. *JAMA*. 2004;292:1711-1716.

32. Davis TC, Arnold C, Berkel HJ, et al. Knowledge and attitude on screening mammography among low-literate, low-income women. *Cancer*. 1996;78:1912-1920.

33. Lindau ST, Tomori C, Lyons T, et al. The association of health literacy with cervical cancer prevention knowledge and health behaviors in a multiethnic cohort of women. *Am J Obstet Gynecol*. 2002;186:938-943.

34. Davis TC, Dolan NC, Ferreira MR, et al. The role of inadequate health literacy skills in colorectal cancer screening. *Cancer Invest*. 2001;19:193-200.

35. Cokkinides VE, Chao A, Smith RA, et al. Correlates of underutilization of colorectal cancer screening among U.S. adults, age 50 years and older. *Prev Med*. 2003;36:85-91.

36. Seeff LC, Nadel MR, Klabunde CN, et al. Patterns and predictors of colorectal cancer test use in the adult U.S. population. *Cancer*. 2004;100:2093-2103.

37. Swan J, Breen N, Coates RJ, et al. Progress in cancer screening practices in the United States: results from the 2000 National Health Interview Survey. *Cancer*. 2003;97:1528-1540.

38. Gordon NP, Hiatt RA, Lampert DI. Concordance of self-reported data and medical record audit for six cancer screening procedures. *J Natl Cancer Inst*. 1993;85:566-570.

39. Montori VM, Rothman RL. Weakness in numbers. The challenge of numeracy in health care. *J Gen Intern Med*. 2005;20:1071-1072.

40. Golbeck AL, Ahlers-Schmidt CR, Paschal AM, et al. A definition and operational framework for health numeracy. *Am J Prev Med*. 2005;29:375-376.

41. Kaphingst KA, Zanfini CJ, Emmons KM. Accessibility of web sites containing colorectal cancer information to adults with limited literacy (United States). *Cancer Causes Control*. 2006;17:147-151.

42. Messina CR, Lane DS, Grimson R. Colorectal cancer screening attitudes and practices preferences for decision making. *Am J Prev Med*. 2005;28:439-446. ■